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A STUDY ON THE EFFECTS OF FOREMEN
ON SAFETY IN CONSTRUCTION

By

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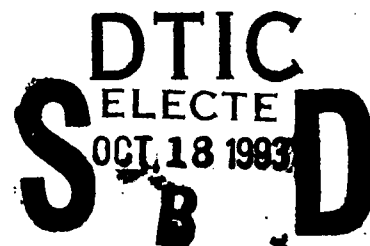
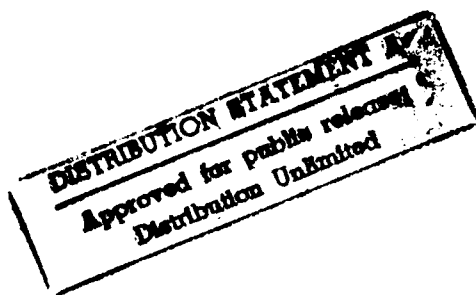
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ABSTRACT

A research study on construction safety is presented in this paper. The primary purpose is to determine how construction trade foreman impact safety performance through their management practices. Data were collected through personal interviews with roofing construction foreman. The foreman were asked about their "management practices", "trade background", "amount of experience" and their "safety record". Comparisons were then made between different foremen on the basis of the frequency of injuries on their jobs. Results showed that the amount of experience of a foreman is related to jobsite safety. The type of roofing installed, and working on flat roofs verses sloped roofs, has an influence on safety. Further, it was shown that the more time a foreman spends on the job reduces the injury frequency. The study also shows there may be a tendency for union foremen to have lower injury frequencies than open shop foremen.

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A STUDY ON THE EFFECTS OF FOREMEN
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1. INTRODUCTION

Safety is a major concern in the construction industry. Accidents receive particular attention since injuries have a direct impact on the cost of insurance. Management of a construction company plays a key role in establishing the attitude towards safety.

The foreman on a construction project represents the first line of supervision, a link between the work crew and upper management. The foreman has the distinction of being part of management and labor. As a journeyman craftsman, the foreman is part of the "hands-on" labor. However, the foreman is also part of management. It is this dual role which makes the foreman the key person on the job in matters concerning production and more importantly safety. Additional responsibilities include the indoctrination and training of apprentices and new hires.

Foreman differ in their styles of managing their crews. The differences may be the result of prior training, "imprinting" resulting from work done under other foreman or even deliberate attempts on the part of a foreman to set a particular tone on the job. Although these styles vary considerably, little is known about how such practices influence safety performance.

Based on safety research, there is strong reason to believe that the foreman, through job practices, plays a key role in safety. Although the importance of this role is apparent, research has not established well-defined characteristics or practices which lead to better safety performance. The results of past construction safety research findings can serve as a base of further study in this area. It is the purpose of this paper to present the findings of such a study.

The focus of this study is on how the practices of roofing foreman effect the frequency of injuries on their construction sites. Information was collected through the interviews on crew and personnel management practices, job management practices, on the job safety policies, and on safety attitudes of the foremen. It is the aim of this research to identify those practices of foremen which create safer work environments and result in fewer injuries.

2. LITERATURE REVIEW

Since this research was focused on safety in construction, the review of literature was also focused specifically to the construction industry. The primary focus of this literature review is to discuss and present the significant findings of two previous studies on the attitudes and practices of foremen who supervise construction crews. These studies were conducted several years apart and in different work settings.

The first study, conducted in 1974, focused on various trade foremen working for eight construction companies conducting projects in the San Francisco Bay Area [1]. Forty two experienced foreman from six construction trades were interviewed by research assistants for this study. The interviews consisted of 24 questions about each foreman's techniques for handling supervisory duties. The study group consisted primarily of carpenter foremen , labor foremen and operating engineers. The types of projects these foremen worked on were primarily building construction projects and highway projects. Sixty six percent of the foremen were over forty years of age. Sixty percent had twenty or more years of construction experience. Twenty five percent of them have twenty or more years of foremen experience.

The study investigated the relationship between the foremen and their corresponding productivity and safety records. Productivity was measured by an assessment of each foreman's ability to: meet costs, achieve production, work under pressure and effectively administrate. These assessments were made by each foreman's supervisor. The measure of safety was the lost-time accident average for each foreman's crew. Statistical analysis was used to test the significance of the relationship between the foreman management methods and the productivity and safety measures.

The results of the San Francisco Bay Area foreman study indicated that there was no significant relationship between productivity and safety. That is, safety was not found to hinder or enhance productivity. The study did find that a foreman's methods of handling new workers in their crews was related to safety. Foremen with better safety records asked job specific questions and kept in contact with the new worker. Foremen with poorer safety records asked the new worker no questions and put the new worker with an older, experienced worker or put the worker directly to work. The study also found that foremen's actions prompted by low productivity of the crew was related to crew safety. Foremen with good safety records were more likely to analyze problems, while foremen with poorer safety records were more likely to pressure the crew or get angry with the crew. Additionally, the study found that foremen who could suppress their anger had better safety records than foreman who expressed anger at or around their crews.

The second study, conducted in 1979, focused on pipefitting foreman working on a \$2.8 billion, nuclear power plant project in a rural, farm area for a large midwestern utility company [2]. Thirty two foreman were interviewed by a single researcher, who was a full-time employee at the job site. The project employed over 3000 overhead and craft workers. The pipefitter craft was chosen because it was the largest working group on the job at the time of the study. This study investigated the same aspects of safety as considered in the San Francisco Bay Area study.

In the introduction to each interview, foremen were told that the study was about their ideas of construction. To avoid bias in the answers, none of the questions in the interview mentioned the word safety. The measure of safety used in this study was the "recordable injury frequency" of the foreman's crew. An "injury" was defined as an injury of a crew member requiring a doctor's attention. Each crew's injury frequency was adjusted for each foreman to reflect the incidence of injury for 1,000,000 "worker-hours" of exposure. Statistical analysis was used to test the significance of the relationship between the foreman's work practices and the resultant crew safety performance. This study was very similar to the San Francisco Bay Area study. The surveys used in the two studies were generally the same.

It was found in this study that safer foremen were more watchful over new workers and tended to show a more sincere interest through job indoctrination. Like the Bay Area study it was found that safer foremen were less likely to push crews for more production. In addition this study found that closer job control, was associated with a better safety record. The results showed that safer foremen spent more time in the work area. An additional significant finding made in this study was that safer foremen had input into the work schedule.

3. RESEARCH METHODOLOGY

INTRODUCTION

In order to obtain relevant and comparable data, it was decided to limit the study to construction trade foremen who consistently performed the same type of work. The scope of this research was limited to Seattle-area commercial and residential roofing industry foremen. To provide added consistency to the study, it was decided that each participant in the study should be asked the same questions. Although a mailed survey study was considered, it was decided that this would not lend itself well to the open-ended format to be used for the answers. Thus, it was concluded that personal interviews would be conducted. Personal interviews would also permit the interviewer to capture and relate anecdotal information of interest to the study. The frame work of the personal interview questions was provided by a survey form. This survey form was developed, in large part by referring to the two previously described studies that focused on foreman safety [1&2]. The questions used on these studies were modified and used as the basis of the foremen interviews for this study.

A large source of foreman needed to be established for the interviews of this study. The business agent of the local roofers union, Roofers, Waterproofers and Allied Workers Local #54, provided a mailing list of the 24 roofing contractors signatory to the local roofers union labor agreement. The business agent was also able to provide a mailing list of the members of the 1992-1993 Roofing Contractors Association of Washington. Thirty four of the roofing companies on these lists, conducting projects in the Seattle-area, were asked to participate and provide time for interviews for the roofing foremen they employed. No pre qualifications were identified for the foremen prior to the company's selection of the foremen chosen to be interviewed.

SURVEY DEVELOPMENT

The two previously described safety studies on construction trade foreman hypothesized that construction crew safety was affected in part, by: a) job control; b) job pressures; c) management styles; d) interpersonal relationships; and e) orientation of new workers. The hypotheses developed were as follows:

I. Safer foremen have been working longer, are more experienced, have been around a while and "know the ropes".

II. Safer foremen have smaller crews; they can get to know their fellow workers more personally, and know their abilities and weaknesses.

III. Safer foremen give new hires a more extensive indoctrination; they tell new hires about safety rules and the job in general.

IV. Safer foremen are more personal with crews; they can relate to the workers as being "one-of-the-guys".

V. Safer foremen spend more time at the job site; they are closer to the work and potential problems, and are more readily available to answer questions.

VI. Safer foremen do not give crew members detailed cost/ schedule information, as this could generate job pressures.

VII. Safer foremen have a direct input into the job schedule; they can pace their work so as not to overload the crew.

The basic survey developed by the other two studies was modified for this study primarily by adding questions which have an emphasis on the roofing construction trade. The roofing construction trade generally consists of small projects with duration's from three days to three months. A roofing project crew generally consists of a working foreman with up to eight workers. On Seattle projects where the company is signatory to the local roofers union labor agreement, seven of the workers are journeymen and the other worker is typically an apprentice. One of the workers, usually the senior person on the crew is called the "lead man". The "lead man" is considered to be second in charge on the project. Journeymen union card holders are referred to by the foremen as "carrying a shingle".

On open shop projects, crews generally consist of a working foreman with six crew members of various skill levels, depending on the length of time each worker has been employed by the company. The survey developed by the other two studies was modified by removing questions that did not apply to the smaller roofing projects. Questions concerning reference to general foremen and job superintendents were deleted. Questions concerning the types of roofing the foremen worked on and the amount of time the foremen worked with the tools, were added.

The initial version of the survey was tested by conducting five interviews on roofing foremen to see how they responded to the questions in the survey. All of the foremen thought the survey questions were relevant. The only issue that did surface was whether or not there should also be a question concerning the percentage of work that was "new work" instead of "tear off or "rehabilitation work".

The basic assumption of this type of question is that "new work" is generally easier and safer than "tear off" or "rehabilitation work", however this would not effect the study as a whole since the focus of the study is on effective supervisory methods of roofing foreman as they influence worker productivity and safety. After 10 interviews had been conducted it was concluded that 90-95% of the work performed was "rehabilitation work". The information provided by this question, although interesting, did not provide any additional insight to the study. This question was not added to the survey. The complete eighteen question survey is shown in appendix A.

SELECTION OF THE FOREMEN TO INTERVIEW

It was decided that a large number of roofing foremen should be interviewed. A logical beginning point was to interview foremen who were members of the local roofers union. The business agent of the local roofers union expressed an interest in the study and provided his assistance. This business agent provided a mailing list of the 24 contractors signatory to the labor union's collective bargaining agreement. The foremen employed by these contractors became the initial target or source of foremen to be interviewed in this study. In an effort to keep the travel time to a minimum only the eleven contractors on the list with Seattle mailing addresses were contacted by letter and asked to participate in the research study.

The letter (given in its entirety in Appendix B) described the project as a "study of effective supervisory methods and practices as they influence worker productivity and safety. It described what was needed from the participating companies as follows:

"We would like to interview individual roofing foreman using the enclosed survey. Each interview should last about fifteen minutes and can be conducted on the job site, at the company's office or at the home of the foreman to be interviewed. In addition to the information obtained though the interviews, we would like to obtain additional background information on each foreman, including length of time with the company and management's assessment of the foreman's overall performance".

Initially, the eleven companies on the list were mailed letters requesting their participation in the study. Follow up phone calls were made to each roofing company concerning the study. A minimum of two calls were made to each company to determine if they were interested in participating in the company. The first call was an introduction of the interviewer, the study and a reminder of the letter that was mailed to the company. The company representative would take the researcher's name and number and give it to the person considered the point of contact. The point of contact for the company would typically be the owner of the company or the supervisor of the company's foremen.

A second call was made to the point of contact to determine if the company was interested in participating in the study. By the second call it was generally apparent whether or not the company was interested in participating in the study. On occasion, if the company was interested in participating, a third call was required to specify the time, date and location of the interview. A call was always made to remind the point of contact of the scheduled interview time and date.

Of the initial eleven companies sent letters, five companies expressed an interest in and ultimately participated in the study. These five companies provided eleven of the 28 foremen interviewed in the study. Interviews were conducted either on the jobsite during the morning of a work day or at the company's home office before the foremen left the office for the jobsite. The six companies that did not participate indicated that this was "their peak construction period and did not have the time to participate".

A typical interview on the jobsite would be conducted while the crew was working. The foremen would put the "lead man" in charge and would find a quiet spot on the job to have a conversation. The researcher would lead the discussion using the questions in the survey as a guide. The foreman's answers would be recorded as the interview progressed. Any remarks or elaboration on responses would be written down on the survey form. A typical interview would last about 15-20 minutes.

It was clear that the number of companies on the mailing list needed to be expanded to attain the goal of 40 interviews for the study. The secretary of the Roofing Contractors Association of Washington was contacted in an attempt to obtain the association's mailing list. The request for a copy of the mailing list was denied as the bylaws of the association restricted access to the mailing list to association members. The business agent of the roofers union, however was able to obtain a copy of the mailing list and shared it with the researcher. This list contained the names of the 48 members of the Roofing Contractors Association of Washington. Thirteen companies that were signatory to the collective bargaining agreement with the local roofers union also were members of the Roofing Contractors Association of Washington.

Five companies with Seattle mailing addresses and three companies with addresses considered to be within reasonable commuting distance were mailed letters from the mailing list. Three of the eight companies participated. The five companies not participating indicated that they were very busy and did not have the time. The additional participating companies yielded three more foreman interviews for a total of 14 interviews. The mailing list had to be expanded again to reach the goal of 40 interviews.

Of the 59 roofing companies appearing on the two mailing lists, 34 had Seattle addresses or addresses that were considered within commuting distance (Tacoma to Everett). At this point, 19 of the 34 companies had been mailed letters requesting their participation in the study. The remaining 15 companies were mailed letters requesting their participation in the study. This mailing was done in increments of five letters per week over a three week period. This was done to facilitate "keeping track" of the required phone calls and to keep the interviewing schedule to a workable rate. Of the total 34 Seattle-area companies that were contacted by letter 12 agreed to participate, yielding 28 foreman interviews. Table 3.1 summarizes the mailing effort and number of interviews conducted for each mailing.

TABLE 3.1
SUMMARY OF THE MAILING EFFORT

Mailings	Type Firms	Number of letters sent	Number of Partic. Firms	Number of Interviews
1	Union	11	5	11
2	Union	1	0	0
	Open-Shop	7	3	3
3	Union	1	1	4
	Open-Shop	5	2	4
4	Open-shop	4	2	4
5	Open-Shop	5	1	2
TOTAL	Union	13	6	15
	Open- Shop	21	6	13

DATA ANALYSIS

For analysis, the responses were coded by numbers which represented groupings of the answers. Each code indicated a level of ranking. The coded responses were entered into a computer program using the Statistical Package for the Social Sciences (SPSS). The first step in the analysis was to establish a comparison for each foreman. A ratio called "injury frequency" was developed to measure the safety performance of the foremen. The ratio was computed by dividing the number of doctor case crew injuries over the past five years by the average crew size. This product was multiplied by 100 to establish a measure of safety performance which represented the number of injuries incurred in one million worker hours of crew exposure. This computation assumed 2000 man-hours were worked per year based on a forty-hour week for fifty weeks.

Correlations were then developed between the independent variables and the injury frequency. These correlations were developed in an attempt to show which practices resulted in a safer performance measure (lower injury frequency). Those correlations with levels of significance of less than 5 % are considered significant, those with correlations between 5 % ($P < .05$) and 10 % ($p < .10$) show a tendency towards significance. A correlation coefficient (Kendall's correlation coefficient) was determined for each variable paired with the measure of injury frequency.

4. RESULTS.

The comparison established to measure the safety performance for each foreman was based upon crew injuries over the past five years. Those foremen with less than five years experience were not included in the statistical analysis. Of the 28 interviews conducted, only 19 foremen had five or more years of experience.

The individual variables that exhibited significant or "near" significant correlations with injury frequency (levels of significance less than 10% ($p < .10$)) are presented in the discussions and tables that follow. Tables were developed to show the association of variables correlated with injury frequency. The tables also show the corresponding level of significance, the Kendall's correlation coefficient, the average injury frequency for differing types of characteristics, the median injury frequency and the number of responses. The variables that support the hypotheses and those which appear to support intuitive thoughts on safety are presented first in the order that they appeared on the interview forms. Those variable association with injury frequency that do not support the hypotheses or which cannot be readily explained are presented last.

CORRELATIONS THAT SUPPORT THE HYPOTHESIS

(1) The correlation of the variable "time served as a foreman" (TIMEFORE) with injury frequency indicates that more injuries are associated with foremen who have less experience. As the amount of foreman experience goes up, the injury frequency goes down. This correlation supports the hypothesis that "Safer foremen have been working longer, are more experienced, have been around a while and know the ropes".

TABLE 4.1

SUMMARY OF CORRELATION - VARIABLE TIMEFORE WITH INJURY

FREQUENCY*

Yr. as foreman	Avg. injury freq.	Med. injury freq.	# of responses
8 or above	43.6	46.5	11
5 TO 8	66.6	79.2	8

* Kendall's coefficient = -.283; $p < .05$

(2) The correlation of the variable "type of roof generally installed" (TYPEROOF) with injury frequency indicates that fewer injuries are associated with foremen who install primarily built up roofs. As the type of roofing system differs from built up roofs, the injury frequency goes up. Built up roofs are generally installed on flat roofs. The other roof types (composition shingles, cedar shake, etc.) are installed on sloped roofs.

TABLE 4.2

SUMMARY OF CORRELATION - VARIABLE TYPEROOF WITH INJURY

FREQUENCY*

Type of Roof	Avg. injury freq.	Med. injury freq.	# of responses
built up	43	20	15
various types	78	77.5	2
composition	100	100	1
cedar shake	180	180	1

*Kendall's coefficient = .491; $p < .10$

(3) The correlation of the variable "percentage of roofs worked on that are flat" (PCTGFLAT) with injury frequency indicates a foreman who works on flat roofs has a lower injury frequency. When more roofs worked on are sloped, the injury frequency goes up. This supports intuitive thoughts that flat roofs should be safer to work on.

TABLE 4.3

SUMMARY OF CORRELATION - VARIABLE PCTGFLAT WITH INJURY

FREQUENCY*

Pct flat roofs	Avg. injury freq.	Med. injury freq.	# of responses
0 to 75	92.4	75	8
>75	31.1	11.9	11

*Kendall's coefficient = -.429; $p < .05$

(4) The correlation of the variable "what percentage of your time do you spend on the job" (TIMESITE) with injury frequency indicates a foreman who spends less time at the site has a higher injury frequency. As the amount of time the foreman spends at the job goes up, the injury frequency goes down. This supports the hypothesis that "Safer foremen spend more time at the job site; they are closer to the work and potential problems, and are more readily available to answer questions."

TABLE 4.4

SUMMARY OF CORRELATION - VARIABLE TIMESITE WITH INJURY

FREQUENCY*

% of time at site	Avg. injury freq.	Med. injury freq.	# of responses
1-99%	85.5	83.3	6
100%	43.7	43.7	13

*Kendall's coefficient = -.479; $p < .05$

(5) The correlation of the variable "do foreman inform the crew of the schedule" (MUCHTIME) with injury frequency indicates a foreman who does provide schedule information about the project to the crew has a higher injury frequency. As the amount of time the schedule is withheld from the crew goes up, the injury frequency goes down. This supports the hypothesis that "Safer foremen do not give crew members detailed cost or schedule information."

TABLE 4.5

SUMMARY OF CORRELATION - VARIABLE MUCHTIME WITH INJURYFREQUENCY*

Inform crew of schedule	Avg. injury freq.	Med. injury freq.	# of responses
yes	78.6	78.6	12
no	19.7	19.7	7

*Kendall's coefficient = -.406; $p < .05$

(6) The correlation of the variable "if schedule not provided, why not" (WHYNOTIM) with injury frequency indicates a foreman who does give the schedule information to the crew has a higher injury frequency. As the amount of time the schedule is withheld from the crew, because of concerns about placing pressure on the crew, goes up, the injury frequency goes down. This supports the hypothesis that "Safer foremen do not give crew members detailed cost/schedule information, as this could generate job pressures."

TABLE 4.6

SUMMARY OF CORRELATION - VARIABLE WHYNOTIM WITH INJURY

FREQUENCY*

Why schedule not provided	Avg. injury freq.	Med. injury freq.	# of responses
not applicable (informs crew)	78.6	66.67	12
not given to me	21.1	12.5	5
would pressure crew	16.25	20	2

*Kendall's coefficient = $-.376$; $p < .05$

(7) The correlation of the variable "whether the foremen is associated with an open shop company or a union shop company" (OPENSHOP) indicates a foreman who does not work for a union company has a higher injury frequency. This supports intuitive thoughts that union foremen should feel more secure about their income and ability to find work. It was found during the study that the local roofers union works with the companies to improve safety on the jobsites.

TABLE 4.7

SUMMARY OF CORRELATION - VARIABLE OPENSHOP WITH INJURY

FREQUENCY*

Type company	Avg. injury freq.	Med. injury freq.	# of responses
openshop	83.0	83.0	10
union	27.9	27.9	9

*Kendall's coefficient = $-.401$; $p < .05$

CORRELATIONS THAT DO NOT SUPPORT THE HYPOTHESES

(1) The correlation of the variable "what is your average crew size" (CREWSIZE) with injury frequency indicates a foreman with a smaller crew has a higher injury frequency. As the crew size goes up, the injury frequency goes down. This correlation does not support the hypothesis that "Safer foremen have smaller crews."

TABLE 4.8

SUMMARY OF CORRELATION - VARIABLE CREWSIZE WITH INJURY

FREQUENCY*

# in the crew	Avg. injury freq.	Med. injury freq.	# of responses
1-6	91.3	93.3	9
7 OR ABOVE	25.9	34.3	10

*Kendall's coefficient = $-.546$; $p < .05$

(2) The correlation of the variable "what is done if a crew member is goofing off" (GOOFSOOF) indicates a foreman who spends more time counseling a crew member alone has a higher injury frequency. This does not support the hypothesis that "Safer foremen are more personal with the crews."

TABLE 4.9

SUMMARY OF CORRELATION - VARIABLE GOOFSOFF WITH INJURY

FREQUENCY*

Correct crew	Avg. injury freq.	Med. injury freq.	# of responses
threaten to fire	33.3	33.3	1
take aside	33.6	12.5	10
encourage to keep busy	88.9	75.0	8

*Kendall's coefficient = .399; $p < .05$

(3) The correlation of the variable "if you need to chew out a crew member for improper work" (CHEWIMPR) with injury frequency indicates a foreman who spends more time counseling a crew member has a higher injury frequency. This does not support the hypothesis that "Safer foremen are more personal with the crew."

TABLE 4.10

SUMMARY OF CORRELATION - VARIABLE CHEWIMPR WITH INJURY

FREQUENCY*

Where do you chew out crew	Avg. injury freq.	Med. injury freq.	# of responses
in front of others	16.5	20.0	4
off by himself	67.7	44.44	15

*Kendall's coefficient = .311; $p < .10$

The following table summarizes the results of the variable correlations and provides means and medians of the variables. The variables are presented in the order in which they appeared on the survey form.

TABLE 4.11

SUMMARY OF CORRELATION - VARIABLES WITH INJURY FREQUENCY

Variable	Kendall's Coefficient	P<.1	Variable mean	Variable median	More injuries associated with
TIMEFORE	-.283	.049	10.9	8.0	Less experience as a foreman
TYPEROOF	.491	.0057	1.68	1.0	less pitch roofs
PCTGFLAT	-.249	.007	65.84	75	less flat roof work
CREWSIZE	-.546	.001	6.68	7.0	smaller crew size*
TIMESITE	-.479	.006	97.3	100	less time spent at site by the foreman
MUCHTIME	.406	.021	1.34	1.0	less inf. foreman gives crew about job schedule
WHYNOTIM	-.376	.026	1.56	1.0	less inf. of schedule given to the foreman
GOOFSOFF	.399	.021	3.37	3.0	more effort required by foreman to counsel crew member*
CHEWINPR	.311	.060	1.79	2.0	more effort required by foreman to counsel crew member*
OPENSHP	-.401	.022	1.47	1.0	open shop foremen than union foremen

*Findings contrary to anticipated relationships

REGRESSION MODEL

Two regression models, to estimate injury frequencies for roofing foremen, were developed using the 10 variables that developed correlations with injury frequency of less than 10% ($p < .10$). The first regression model used all 19 foremen interviews for the regression analysis. The model developed indicated that the variables PCTGFLAT and CREWSIZE were significant. No other variables were "pulled into" the regression model. The regression equation developed for this model is:

$$\text{Injury Frequency} = 191 - 11.5*(\text{CREWSIZE}) - .87*(\text{PCTGFLAT}).$$

The second regression model filtered out all foremen with less than 10 years of experience. Only eight foremen interviewed were used for this model. The model developed indicated that the variables TYPEROOF and TIMESITE were significant. No other variables were "pulled into" the regression model. The regression equation developed for this model is:

$$\text{Injury Frequency} = 1000 - 10.3*(\text{TIMESITE}) - 52.7*(\text{TYPEROOF}).$$

The two regression model variables are summarized in table 4.12.

TABLE 4.12

REGRESSION MODEL VARIABLES SUMMARY

REGRESSION MODEL	VARIABLES	R-SQUARE
#1 - 19 Foremen with 5 or more years experience	PCTGFLAT	.537
	CREWSIZE	.666
#2 - 8 Foremen with 10 or more years experience	TYPEROOF	.569
	TIMESITE	.909

5. REFERENCES

1. Samelson, N.M., "The Effect of Foreman on Safety in Construction", Technical Report No. 219, Dept. Of Civil Engineering, Stanford University, Stanford, Calif., June, 1977.
2. McMeel, K., "The Effect of Foremen on Safety on Super Projects," thesis presented to the University of Missouri-Columbia, at Columbia, Mo., in 1979, in partial fulfillment of the requirements for the degree of Master of Science.

APPENDIX A.

FOREMAN SURVEY

ROOFING FOREMAN SURVEY

1. How long have you been doing roofing work?_____ yr.
2. How long have you been a roofing foreman?_____ yr.
3. How long have you been employed by this company?_____ yr.
4. What type of roofing do you generally install?_____.
5. What % of the roofs are flat?_____%
6. How many are in your crew?
 - a. Is that a normal crew size?_____ (Is that typical?)
 - b. What percentage of your time do you work with tools?_____%
7. Suppose you hire a new worker, what do you do with the new worker on the first day on the job?
 - a. _____ Put him right to work.
 - b. _____ Explain the job in general, put him to work with a "veteran" crew member.
 - c. _____ Explain the job in general, put to work, check back later.
 - d. _____ Explain job and safety in general, put with veteran.
 - e. _____ Give thorough orientation-work and safety, keep an eye on the new hire.
 - f. _____ Other:_____.

8. How well do you try to get to know your crew members?

- a. _____ Strictly boss/worker
- b. _____ Mostly business, some personal contact
- c. _____ Get to know thoroughly
- d. _____ Personally - some off site contact
- e. _____ One of the crew

9. How much time do you actually spend with the crew at the job site(s)? _____ %

10. Do you let your crew members know how much time they have to get a job done? a. yes b. no

If no, why?

- a. _____ Not applicable
- b. _____ Information is not given to me.
- c. _____ It does not matter/ It is not necessary
- d. _____ It would put too much pressure on the crew

11. What happens if you do not meet a schedule?

- a. _____ Have a meeting with the crew to "push" them
- b. _____ Reassign crew members from another crew
- c. _____ Do nothing
- d. _____ Try to find out what the problem is

12. Does the company ever ask you how long it will take to do a particular project? If yes how often? _____.

13. What do you do if you see a worker doing his work improperly, which might cause rework?

- a. _____ Tell him to correct it
- b. _____ Correct him on the spot, have an experienced crew member help
- c. _____ Explain how to correct the work
- d. _____ Supervise the rework personally

14. What do you do if you catch a worker "goofing off"?

- a. _____ Nothing, but watch to see how often
- b. _____ Threaten to fire him
- c. _____ Take him aside and tell him to get back to work
- d. _____ Encourage him to keep busy if he's out of work
- e. _____ Discuss the problem at the tool box meeting without mentioning names

15. If you have to chew a crew member out do you find it more effective to do it in front of others or off by himself?

How about?

- a. For safety violations?
- b. Doing the work incorrectly?
- c. For goofing off?

16. As a foreman in the past five years how many "doctor case" injuries have you had in your crew?

17. How many first aid type accidents?

18. What is done to maintain the safety of workers when up on a roof? _____.

APPENDIX B.

SAMPLE LETTER TO COMPANIES INVITING PARTICIPATION

13 July 1993

Pacific Star Roofing, Inc.
12902 Hwy. 99 South
Everett, WA 98204

As part of the University of Washington's Graduate Program of Construction Engineering and Management, we are conducting a study of effective supervisory methods and practices of roofing foreman as they influence worker productivity and safety. We are writing to ask your company to participate in this Seattle area study.

Our study will focus on the effectiveness of the supervisory practices of foremen. We feel that foremen play an instrumental role in the industry and we would like to find out more about what makes them effective.

We would like to interview individual roofing foreman using the enclosed survey. Each interview should last about fifteen minutes and can be conducted on the job site, at the company's office or at the home of the foreman to be interviewed. In addition to the information obtained through the interviews, we would like to obtain additional background information on each foreman, including length of time with the company and management's assessment of the foreman's overall performance.

We feel this study is important and can make a significant contribution to our knowledge about the effectiveness of foreman. We will contact your office in the next two weeks to discuss this study with you. We will share the findings of our study with all participating firms. The anonymity of all participants is assured.

Yours Truly,

Jim Hinze
Professor
Phone (206) 543-7331(W)
Fax (206) 543-1543

Robert Hymel
Research Assistant
(206) 437-0156 (H)

APPENDIX C.

DATA VARIABLES AND DATA FILES FOR SPSS

DATA VARIABLES

DATA LIST FILE = "HYMEL.DAT";

IDNUMBER 1-2 TIMEROOF 4-6 TIMEFORE 8-10 TIMEFIRM 12-14 TYPEROOF 16
PCTGFLAT 18-20 CREWSIZE 22-23 PCTTOOLS 25-27 NEWHIRES 29 KNOWCREW 31
TIMESITE 33-35 MUCHTIME 37 WHYNOTIM 39 SCHEDULE 41 ASKTIMES 43-45 IMPROPER 47
GOOFSOFF 49 CHEWSAFE 51 CHEWIMPR 53 CHEWCOOF 55 DOCCASES 57 FIRSTAID 59-60
MAINTAIN 62 OPENSHOP 64.

VARIABLE LABELS

/IDNUMBER "NUMBER ASSIGNED TO THE FOREMAN"
/TIMEROOF "TIME FOREMAN HAS DONE ROOFING WORK - YRS"
/TIMEFORE "TIME SERVED AS A ROOFING FOREMAN - YEARS" ✓
/TIMEFIRM "TIME EMPLOYED BY THE COMPANY - YEARS"
/TYPEROOF "TYPE OF ROOFING GENERALLY INSTALLED" ✓
/PCTGFLAT "WHAT % OF ROOFS WORKED ON ARE FLAT" ✓
/CREWSIZE "WHAT IS YOUR AVERAGE CREW SIZE" ✓
/PCTTOOLS "WHAT % OF TIME ON JOB DO WORK WITH TOOLS"
/NEWHIRES "WHAT FOREMAN DO WITH NEW HIRE ON THE JOB"
/KNOWCREW "HOW WELL DO FOREMAN GET TO KNOW THE CREW"
/TIMESITE "WHAT % OF TIME IS SPENT AT THE JOB" ✓
/MUCHTIME "DO FOREMAN INFORM CREW OF THE SCHEDULE" ✓
/WHYNOTIM "IF SCHEDULE NOT PROVIDED, WHY NOT" ✓
/SCHEDULE "WHAT DO FOREMAN DO IF SCHEDULE NOT MET" ✗
/ASKTIMES "DOES COMPANY ASK INPUT TO JOB DURATIONS"
/IMPROPER "WHAT IS DONE IF CREW WORKING IMPROPERLY"
/GOOFSOFF "WHAT IS DONE IF CREWMEMBER IS GOOFING OFF" ✓
/CHEWSAFE "IF NEED TO CHEW MEMBER OUT FOR SAFETY"
/CHEWIMPR "IF NEED TO CHEW MEMBER FOR IMPROPER WORK" ✓
/CHEWCOOF "IF NEED TO CHEW MEMBER FOR GOOFING OFF"
/DOCCASES "IN PAST 5 YRS, DOCTOR INJURIES REPORTED"
/FIRSTAID "IN PAST 5 YRS, FIRSTAID INJURIES"
/MAINTAIN "WHAT IS DONE FOR CREW SAFETY ON THE ROOF"
/OPENSHOP "IS THE COMPANY OPENSHOP OR UNION". ✓

VALUE LABELS

/TYPEROOF 1 "BUILT-UP ROOF" 2 "TORCH DOWN ROOF" 3 "COMPOSITION ROOF"
4 "CEDAR SHAKE" 5 "VARIOUS TYPES"
/NEWHIRES 1 "PUT RIGHT TO WORK" 2 "EXPLAIN PUT WITH VET"
3 "EXPLAIN CHECK LATER" 4 "SAFETY TALK WITH VET"
5 "SAFETY TALK & WATCH" 6 "OTHER METHOD GIVEN"
/KNOWCREW 1 "STRICT BOSS/WORKER" 2 "MOSTLY BUSINESS"
3 "GET TO KNOW WELL" 4 "SOME OFF SITE"
5 "ONE OF THE CREW"
/MUCHTIME 1 "YES" 2 "NO"
/WHYNOTIM 1 "NOT APPLICABLE" 2 "NOT GIVEN TO ME"
3 "NOT NECESSARY" 4 "TO MUCH PRESSURE"
/SCHEDULE 1 "PUSH CREW" 2 "REASSIGN CREW MEMBERS"
3 "DO NOTHING" 4 "FIND OUT THE PROBLEM"
/IMPROPER 1 "TELL TO CORRECT" 2 "CORRECT, VET ASSIST"

3 "EXPLAIN CORRECTION" 4 "SUPERVISE PERSONALLY"
/GOOFSOFF 1 "NOTHING, WATCH HIM" 2 "THREATEN TO FIRE"
3 "TAKE ASIDE BACK WORK" 4 "ENCOURAGE KEEP BUSY"
5 "DISCUSS TOOL BOX MTG"
/CHEWSAFE 1 "IN FRONT OF OTHERS" 2 "OFF BY HIMSELF"
/CHEWIMPR 1 "IN FRONT OF OTHERS" 2 "OFF BY HIMSELF"
/CHEWGOOF 1 "IN FRONT OF OTHERS" 2 "OFF BY HIMSELF"
/MAINTAIN 1 "COMPLY WITH WISHA" 2 "PROVIDE WARNING LINES"
3 "PROVIDE MONITOR" 4 "FIRST AID KIT" 5 "ALL OF ABOVE"
/OPENSHOP 1 "OPENSHOP" 2 "UNION".

COMPUTE D = (DOCCASES / CREWSIZE)*100.

COMPUTE F = (FIRSTAID / CREWSIZE)*100.

SELECT IF (TIMEFORE GE 5).

DATA FILES FOR SPSS

01+003+001+002+2+999+05+100+5+2+100+2+4+4+005+2+3+1+1+2+0+40+5+2
02+007+1.5+0.6+1+099+07+100+5+2+100+2+4+4+010+2+3+1+1+1+7+60+5+2
03+1.8+1.8+1.8+2+050+03+100+5+5+090+1+1+4+100+3+4+2+2+2+0+00+5+2
04+008+003+007+2+090+04+025+5+2+090+1+1+1+075+2+3+2+2+2+4+04+5+2
05+005+002+005+2+020+05+095+5+2+090+1+1+2+000+3+3+1+2+2+3+10+5+2
06+006+003+001+2+100+03+050+4+2+100+1+1+4+000+3+5+2+2+2+0+00+5+2
07+026+019+003+1+100+09+099+1+1+099+1+1+4+090+4+3+1+2+2+6+12+1+2
08+021+016+1.5+1+090+09+095+3+4+100+2+2+1+095+4+3+1+2+2+1+20+1+2
09+014+007+014+1+090+06+080+3+3+100+1+1+1+090+4+3+2+2+2+1+60+1+2
10+017+010+017+1+050+06+085+4+5+095+1+1+4+095+4+3+2+2+2+4+10+1+2
11+008+006+008+5+025+08+080+4+4+080+1+1+1+025+1+4+1+2+2+6+50+1+1
12+022+012+010+1+085+06+075+1+2+100+1+1+3+000+4+2+1+1+1+2+00+5+2
13+004+002+004+3+010+03+100+5+3+090+1+1+1+030+4+5+1+2+2+3+50+1+1
14+004+002+004+3+050+04+090+5+4+080+1+1+4+100+4+4+1+2+2+3+50+1+1
15+2.5+001+2.5+3+020+03+099+5+4+080+2+4+4+060+2+3+2+2+1+1+01+1+1
16+016+011+003+4+001+05+100+5+5+100+1+1+4+025+4+4+2+2+1+9+20+1+1
17+016+008+015+1+010+02+090+3+2+100+1+1+2+010+3+4+2+2+2+4+25+1+1
18+024+017+021+1+070+08+095+4+4+100+2+2+4+000+2+3+1+2+2+3+60+1+1
19+017+008+016+1+075+08+080+3+4+100+2+2+4+010+4+3+2+2+2+1+60+1+2
20+032+025+001+1+070+07+080+5+2+100+1+1+4+000+4+3+2+2+2+0+60+1+2
21+019+006+019+1+080+09+098+5+3+100+2+2+4+000+2+4+2+2+2+4+60+1+2
22+030+020+012+1+090+10+100+5+4+100+2+2+3+010+2+3+1+1+1+0+30+1+2
23+011+005+011+1+095+09+100+5+2+100+1+1+1+020+4+3+2+2+2+0+10+1+1
24+015+007+015+5+050+05+075+5+5+090+1+1+4+000+3+4+2+2+1+4+01+5+1
25+008+005+008+3+010+03+100+5+4+095+1+1+4+010+4+4+1+2+2+3+50+5+1
26+016+007+006+1+075+08+090+5+4+100+4+4+4+100+4+4+1+1+1+1+60+1+1
27+010+006+010+1+090+05+080+4+2+100+2+4+1+100+4+4+1+1+1+1+60+1+1
28+013+012+013+1+095+04+090+4+2+090+1+1+4+100+4+3+1+2+2+5+60+1+1

APPENDIX D.

LIST OF PARTICIPATING COMPANIES

HAIGHT ROOFING COMPANY, INC.
4910 15TH NW
PO BOX 70150
SEATTLE WA 98107

PACIFIC SHEET METAL INC.
111 SOUTH SPOKANE STREET
SEATTLE WA 98134

LOBERG ROOFING &
CONSTRUCTION, INC.
P.O. BOX 6386
LYNNWOOD, WA 98306

EDMONDS ROOFING
P.O. BOX 571
EDMONDS WA 98020

MEYER BROTHERS ROOFING, INC.
7777 DETROIT AVE SW
SEATTLE WA 98106

PIONEER MASONRY RESTORATION
CO., INC
1100 NORTHWEST 54TH
PO BOX 70110

QUEEN CITY SHEET METAL &
ROOFING, CO.
1711 OCCIDENTAL AVENUE SOUTH
SEATTLE WA 98134

C.C.I. EXTERIORS, INC
922 N 128TH
SEATTLE WA 98133

ROOFING SYSTEMS, INC.,
P.O. BOX 3781
KENT, WA 98032

BOSNICK ROOFING
2915 68TH AVE. W
TACOMA WA 98466

STANLEY ROOFING
19710 - 14TH AVE. NE
WOODINVILLE, WA 98072

SUCCESS ROOFING, INC
23605 156TH AVE. SE
KENT, WA 98042